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# RAC EQUIPMENT TRIALS WING

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REPORT

RED PHOSPHORUS JACK GRENADE

PICATINNY ARSENAL  
SCIENTIFIC AND TECHNICAL INFORMATION BRANCH

Reg. 57562

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(48)  
March 68

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REPORT ON  
PROJECT 473

RED PHOSPHORUS JACK GRENADE

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Approved for Public Release  
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Date : 28th March 1968

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A B S T R A C T

CDEE PORTON have produced a Red Phosphorus Jack Grenade for AFV local smoke protection, with the object of combining the rapid screening qualities of the No 80 White Phosphorus with the quicker loading and reduced fire hazard of the L5 and L7 Jack Grenades. The Red Phosphorus grenades as tested took even longer to provide an effective screen, 35 seconds, than the 26 seconds for the L7 Grenade. The duration of the screen was better, 87 seconds as opposed to 37 seconds. In other respects it was satisfactory. Its smoke is light grey and is not as noticeable as the White Phosphorus smoke, but is more noticeable than the L7 screen.

It is thought that development may overcome the present slowness in the build-up rate of the Red Phosphorus Grenade.

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REPORT ON  
PROJECT 473

RED PHOSPHORUS JACK GRENADE

INTRODUCTION

Background

1. Since 1958 trials have taken place to discover a suitable replacement for the No 80 White Phosphorus Grenade for AFV local smoke protection. The L5 and L7 Jack Grenades were designed for this reason and were found still to have certain limitations.
2. While the No 80 White Phosphorus Grenade produced a rapid and usually adequate screen, it took nearly half an hour to prepare and load. As the White Phosphorus is ignited by exposure to air, and the No 80 Grenade is very vulnerable to small arms fire, the overall safety of the system is poor.
3. The L5 and L7 Jack Grenades are better in that replenishment takes only one minute, and they are inherently safer, but their screen does take longer to build up.
4. To overcome the disadvantages of both systems, CDEE PORTON have now designed a Jack Grenade containing a Red Phosphorus filling, and this grenade was offered to RAC ETW for trial.

Authority

5. MOD AEP 17 Application for RAC Equipment Trial A/70/Ammo/85 dated 30th January 1968, reproduced at Annex A.

AIM

6. To compare the qualities of the Red Phosphorus Jack Grenade with the L7 Jack Grenade and the No 80 White Phosphorus Grenade.
7. The L5 Jack Grenade was not available for this trial.

EQUIPMENT

8. A list of equipment used is at Annex B.

Description of the Red Phosphorus Jack Grenade

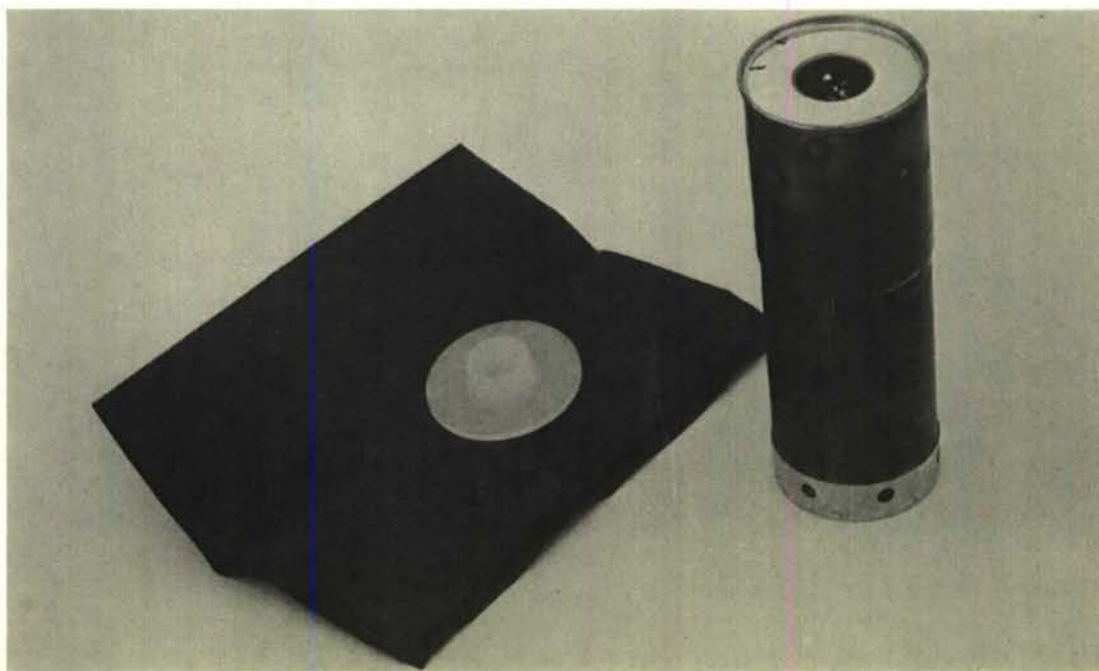


Plate 1 Red Phosphorus Jack Grenade and its Plastic Protective Cap



9. The Red Phosphorus Jack Grenade weighs 1lb 8oz, is 7in long and 2½in in diameter. No separate propelling charge, fuse or detonator is required as the grenade is ejected from the dischargers by an integral, electrically-initiated charge. This charge also ignites a three second burning fuse to the main burster, which ignites and fragments the red phosphorus filling. A plastic cap (as shown in Plate 1) is provided to protect the jack socket when the grenade is removed from its storage container for stowage on the vehicle.

#### Range Layout and Meteorological Conditions

10. These are given at Annex C.

#### TEST 1 - SCREENING PERFORMANCE

##### Aim

11. To compare the screening qualities of the Red Phosphorus Jack Grenade with those of the L7 Jack Grenade and No 80 White Phosphorus Grenade.

##### Method

12. Firings were carried out with various discharger loadings of different types of grenades, as shown in Annex D, to ascertain :

##### a. Screening :

- (1) Rate of build up.
- (2) Time to provide an effective screen.
- (3) Duration of screen.
- (4) Range from vehicle at which screen is produced.

##### b. Reliability :

- (1) Misfires.
- (2) Malfunctions.

13. All firings were conducted from a hull-up CHIEFTAIN Mk 2 and CENTURION (for No 80 White Phosphorus only) on a 1° 50' reverse slope, and three groups of observers were used.

##### Results

14. The detailed results of all firings are at Annex D. It will be seen from the summary of results in Table 1 below that the Red Phosphorus Grenade produces an ineffective screen when fired with three grenades either side, and that when a full load is fired the build up time is poor but duration time good.

TABLE 1 Summary of Screening Performance Results

Serial	Type of Grenade	Annex D Series No	Number and Position of Grenades	Time to Tk Obscured (secs)	Time to Tk Screened (secs)
(a)	(b)	(c)	(d)	(e)	(f)
1	Red Phosphorus	2	6, 3 in each discharger	90	80
2	L7	5	6, 3 in each discharger	23	22
3	Red Phosphorus	4	12, full load	35	87
4	L7	7	12, full load	26	37
5	No 80 WP	10	12, full load	11	23

15. Two Red Phosphorus and one No 80 Grenade failed to either travel the normal distance from the vehicle or function correctly. The Red Phosphorus grenades did not fully disintegrate and the fuse failed to ignite on the No 80 grenade.



16. Other points noted were :

- a. The colour of the red phosphorus screen was light-grey.
- b. The bright metal caps of the red phosphorus grenades contrasted with the rest of the tank and could be picked out individually at 300m.
- c. Tin foil was left after firing in the discharger cups from three out of the 27 red phosphorus grenades.

TEST 2 VULNERABILITY TO SMALL ARMS FIRE

Aim

17. To determine the reaction of the three types of grenade when engaged by small arms fire.

Method

18. Aimed, single shots of both ball and tracer 7.62mm ammunition were fired at individual grenades, which were in smoke dischargers, 30m down range. Six grenades of each type were used. The red phosphorus and L7 were head-on, the No 80 were side on to the tank.

Results

19. Detailed results and some photographs are at Annex E. These are summarised in paras 20 to 22 below.

20. Red Phosphorus :

- a. Neither of the two grenades penetrated by ball reacted to being hit.
- b. The four grenades penetrated by tracer bullets disintegrated, spreading red phosphorus over a fairly wide area. Most of the phosphorus would have cleared the parent vehicle, but some would have fallen onto it.
- c. Two grenades came out of their dischargers before disintegrating. One went 25m and would have cleared its parent vehicle, but the other merely fell out, and, depending on the discharger cup orientation, could have landed on the parent vehicle.

21. L7 Grenades :

- a. All grenades were set off, emitting green smoke.
- b. One grenade burst into flames, with possible adverse effect on any parent vehicle.
- c. As in para 20c. above, with the red phosphorus grenades, two L7 grenades came out of their cups, and one might have fallen onto the parent vehicle although the other would have cleared it.

22. No 80 White Phosphorus :

- a. In all cases the white phosphorus burnt fiercely in the grenade, and in all but one case there was a considerable flow of burning, molten phosphorus that would have fallen onto the parent vehicle.
- b. All grenades were set off by both ball and tracer ammunition.
- c. The burning phosphorus from one grenade appeared not to have effect on any other.
- d. None of the grenades came out of their dischargers, but this may have been because the F103 fuses were not fitted, for safety reasons.

TEST 3 LOADING TIMES

Aim

23. To determine the times taken by one crewman to load 12 grenades of each variety.



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### Method

24. The times taken were from the loader emerging from the vehicle and removing the grenades from stowage bins, until the grenades were loaded and the loader back inside the turret.

### Results

25. The loading drill and safety precautions for the Red Phosphorus Grenade are identical to those for the L7. The vehicle master switch is turned off, the grenades placed in their dischargers, and - keeping all crewmen clear of the dischargers, the master switch is turned on again. The No 80 grenade loading drill is much more complex. The grenades have to be primed and fuze F103 fitted in each discharger cup before the grenades are placed in the cups and the safety pins removed. The comparative times for loading were :

- a. Red Phosphorus and L7 Grenades. 65 secs.
- b. No 80 White Phosphorus Grenades. 15 mins, this did not include priming, which would have taken another five minutes.

## DISCUSSION

### Red Phosphorus Grenade

26. The red phosphorus grenade produced an ineffective screen when three grenades were fired from each side. When twelve grenades were fired an effective screen was produced over a 100° arc. However, there was a very long build-up time, and, at first, the screen was not dense enough.

27. It was noticed on all occasions that the red phosphorus was itself scattered over a wide area. Although the grenades usually landed approximately 200ft from the vehicle, some particles of smouldering phosphorus were found 30ft from the vehicle. The fragments varied in size from 1cm in diameter to the full calibre of the grenade. The fragments did not always burn effectively but smouldered for up to 15 minutes.

28. The colour of the red phosphorus smoke screen was light grey, it is more conspicuous than the L7 smoke but not as conspicuous as the bright white smoke of the No 80 grenade.

29. The grenade itself was easily distinguishable from the rest of the vehicle from 300m, because of its bright metal cap contrasting with the vehicle. This must be dulled, and even future trial grenades should have a neutral shade of paint on them.

30. It was found that the exterior turret grenade bin lids would not close while the red phosphorus grenade had its plastic protective cap on, because of the projection on it. This should be removed, or a protective cap similar to the 'opened tin' closure plastic cap as used on the L7 be adopted.

### L7 and No 80 White Phosphorus

31. The L7 and No 80 white phosphorus grenades had better build-up times than the red phosphorus, but the duration of screen was much less.

### Effect of Small Arms Fire

32. Red Phosphorus Grenade. It would appear that only trace ammunition will set off this grenade, but a further trial would be necessary to prove this completely, as only two of the grenades were hit by ball. Some grenades exploded in their dischargers and continued to burn for up to 13 minutes. The explosions caused might be a hazard to the parent vehicle, but the red phosphorus particles were small and scattered over a wide area.



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33. L7 Jack Grenades. The L7 grenades were set off by both ball and trace ammunition. Some grenades burnt more vigorously than others, but all emitted the normal green smoke. One grenade burst into flames, and this would almost certainly have set the vehicle camouflage on fire and would have been distinctly visible at night.

34. No 80 White Phosphorus Grenades. These grenades were readily ignited by either ammunition, and usually remained in their dischargers. This may have been because the F103 fuses were not fitted, for safety reasons. However, they would be a very great hazard to the vehicle and crew, especially the driver, should his hatch be partially open or not sealed against fluid seepage.

CONCLUSIONS

35. Screen Effectiveness. From Test 1 it is concluded that :

- a. Screen Build-Up Time. The time taken by all the grenades to provide an effective screen is too long, even when a full salvo is fired. White Phosphorus is best, and Red Phosphorus (in the form tested) the worst, as is shown by the timings below :

(1) No 80 White Phosphorus Grenades	11 seconds.
(2) L7 Grenades	26 seconds.
(3) Red Phosphorus Grenades	35 seconds.
- b. Duration. The Red Phosphorus grenade screen duration was the best, and could be reduced if this were to overcome its poor time of build-up.
- c. Azimuth Coverage. The azimuth coverage from all types was 1800° (100° approx) and is satisfactory.
- d. Conspicuousness. On the heathland where the trial was carried out, the green smoke of the L7 Grenade was the least conspicuous. The light grey smoke of the Red Phosphorus may well be a better colour for universal use, however. The White Phosphorus smoke would be most obvious in all backgrounds except snow.

36. Vulnerability. From Test 2 it is concluded that :

- a. The No 80 White Phosphorus Grenade is unacceptable because of the extreme hazard it poses to its parent vehicle when penetrated by small arms fire.
- b. The L7 Grenade is equally vulnerable to ball or trace small arms fire. It does not provide a direct hazard to its parent vehicle but it may :
  - (1) Set camouflage alight.
  - (2) Disclose the position of the vehicle at night.
  - (3) Blind the crew with its smoke.
- c. The Red Phosphorus Grenade appears to be inert when penetrated by ball but is set off by tracer bullets. When struck by tracer it disintegrates with much the same secondary hazards as the L7 Grenade.

37. Handling. From Test 3 it is concluded that :

- a. The No 80 White Phosphorus Grenade requires an unacceptably long time to load, 15 minutes minimum for a salvo, and is generally undesirably hazardous to handle at all times.
- b. The L7 and Red Phosphorus Grenades require no priming, are not hazardous in normal conditions and a full salvo can be loaded in under 1½ minutes by one man.



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RECOMMENDATIONS

38. It is recommended that :

- a. Further development work should be carried out by CDEE FORTON to see if a more instantaneous and dense screen can be attained from the Red Phosphorous Grenade.
- b. The plastic protective cap be redesigned to enable correct fitting into stowage bins with these caps in place.
- c. Although these are trial grenades, the Red Phosphorus Grenade should have a dark green or black end cap, and not plain bright metal.
- d. The use of the No 80 White Phosphorus grenade is discontinued in the RAC because of the serious hazards it offers to crews and vehicles under active service conditions.

## APPLICATION FOR RAC EQUIPMENT TRIAL

Annex A to TR 473

dated 28~~4~~ Mar 68To be carried out at .....  
EQUIPMENT TRIAL AREA

Army Dept Ref 4/71/100/85		HQ RAC Centre Ref		RAC Equipment Wing Ref	
<u>Title of Trial</u> Red Phosphorus Jack Grenade			<u>Originator of Trial</u> Arty 2		
<u>OBJECT OF TRIAL</u> To compare the screening qualities of the Red Phosphorus Grenade with smoke grenades already in service					
<u>EQUIPMENT</u>					
<u>To be issued by</u> Arty 2		<u>Approx date of arrival</u> Early Feb 68		<u>Disposal after trial</u> N/A	
<u>Description of Equipment</u> JACK GRENADES with red phosphorus filling.					
<u>AMMUNITION</u>					
<u>Authority for use</u> IG 67	<u>Quantity</u> 100	<u>Type</u> Red Phosphorus	<u>Issued by</u> Arty 2		
Crew of To be supplied by		as necessary To arrive not later than		10.7.68 RAC Centre	
<u>Originators Instructions and Directions for the Trial</u> This grenade has been designed to overcome many of the disadvantages of the IG, 47 and IG 80 etc. The trial should compare the Red Phosphorus Grenade with these three with particular reference to rate of build up, density and duration. Colour should be commented upon.					
<u>Target date for completion</u> As soon as possible					
<u>Report to be submitted to</u> Arty 2					
<u>Copies to :</u> Normal distribution					

To the Commander RAC CENTRE  
for necessary action.

AEP 17

WH 9400 Ext 44

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Major General

Director of Army Equipment Policy



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Annex B to TR 473  
dated 28th Mar 68

EQUIPMENT

1. Tests 1.

- a. One CHIEFTAIN Mk 2 No 02 EB 39.
- b. One CENTURION Mk 12 No 91 BA 50.
- c. 2 x 6ft square targets.
- d. 15 white, blue and red stakes.
- e. One time-lapse camera.
- f. One cinecamera.
- g. 4 x stopwatches.
- h. Tape measure.
- j. Anemometer.
- k. 4 x A41 radio sets.
- 1. (1) 45 x Red Phosphorus Grenades.  
(2) 48 x L7 Grenades.  
(3) 48 x No 80 White Phosphorus Grenades.

2. Test 2.

- a. One CHIEFTAIN Mk 2 No 02 EB 39 with coaxial GPMG mounted.  
One CHIEFTAIN Mk 1 No 02 EB 28 with cameraman.
- b. 3 x smoke grenade dischargers on a stand.
- c. 6 x grenades of each type.
- d. One cinecamera.

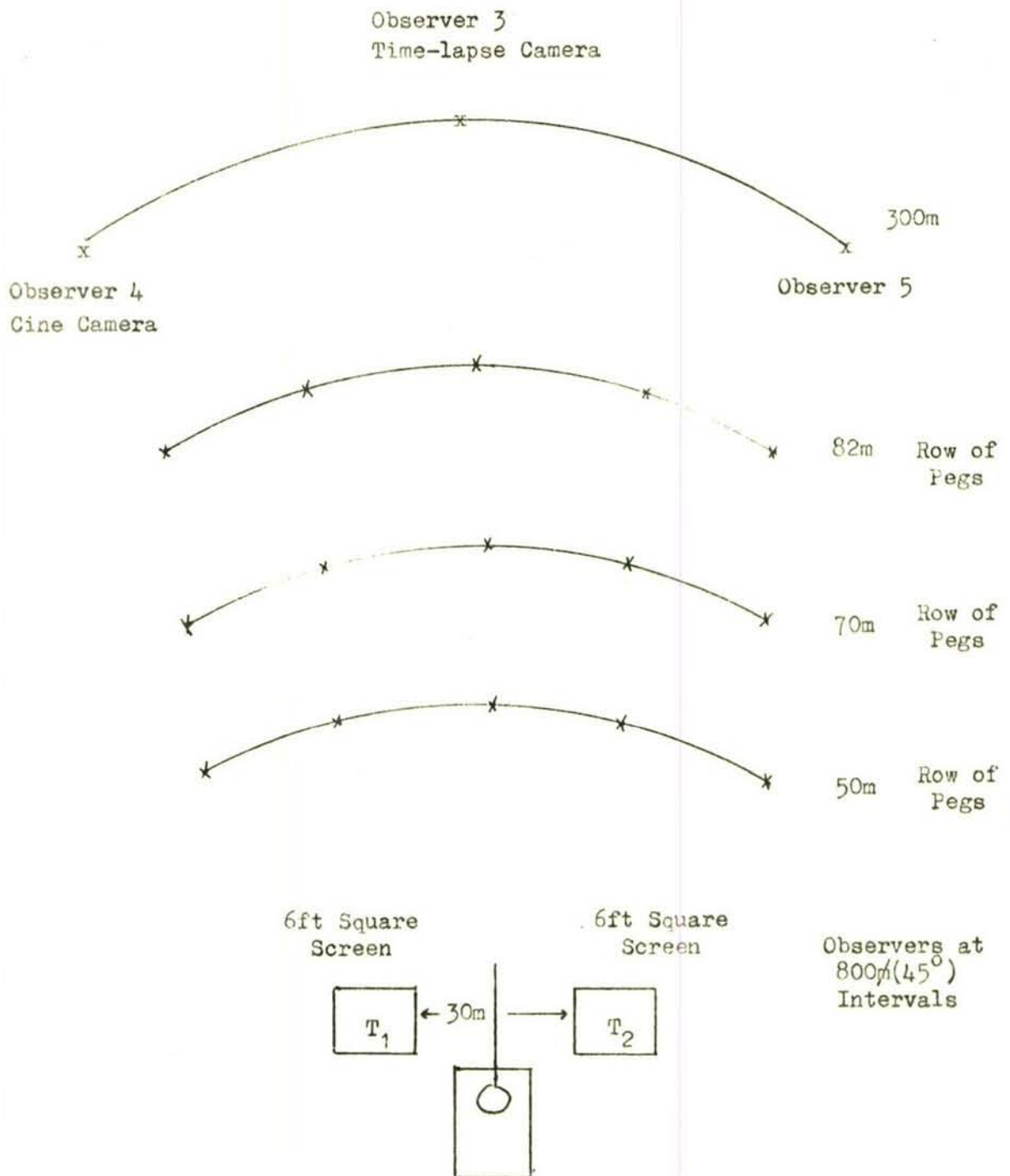
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RANGE LAYOUT AND METEOROLOGICAL CONDITIONS

Annex C to TR 473  
dated 28th Mar 68

1. Range Layout :



2. Meteorological Conditions :

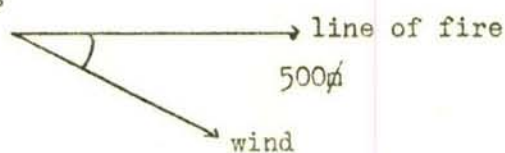
a. Temperature :

- (1) DRY Bulb °F 37
- (2) WET Bulb °F 36

b. Humidity - 91%

c. Wind :

- (1) Speed - 4ft/s
- (2) Direction



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Annex D to TR 473  
dated ~~28~~ March 68

DETAILS OF RESULTS OF TEST 1 - SCREENING PERFORMANCE

1. Series and Times. The series fired and times to tank and side target obscuration and reappearance are given in Table 1 below.

TABLE 1 Quantity and Position of Grenades Used, and Screen Timings.

Serial (a)	Detail (b)	Red Phosphorus Grenade				L7 Grenade				No 80 White Phosphorus Grenade (k)	No 80 White Phosphorus Grenade (l)				(m)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
1	Series	1	2	3	4	5	6	7	8	9	10				
2	No of rounds/ Discharger	3 LH	3 LH	6 LH	12 LH	3 LH	6 LH	12 LH	3 RH	6 LH	12 LH				
3	Observer	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5	4 3 5				
4	Time(sec) to tk obscured	27 36 NE	NR 90 NR	34 33 NE	24 65 16	NR 23 NR	18 24 NE	19 30 29	NE NR 7	29 12 NE	14 12 8				
5	Average	31.5		33	35		21	26		10.5	11				
6	Time(sec) to T <sub>1</sub> , T <sub>2</sub> obscured	NE NR NE	NR 95 NR	NR 38 NR	28 70 36	NR 33 NR	46 NR NE	20 30 17	NE NR 8	10 37 NE	16 16 8				
7	Average	NR			45			22		23	13				
8	Time(sec) to windows closed	NE NR NE	NR 95 NR	57 38 NE	34 70 45	NR NR NR	46 NR NE	41 34 34	NE NR NR	18 37 NR	21 18 13				
9	Average	NR		42	50	NR		36	NR	27	17				
10	Time(sec) to tk reappears	58 72 NE	NR 170 NR	78 195 NE	94 160 112	NR 45 NR	62 53 NE	60 70 60	NE NR 50	27 57 NE	22 50 31				
11	Average	65		136	122		57	63		42	34				
12	Total Duration of screen(sec)	74 180 NE	NR 300 NR	120 240 NE	145 240 120	NR 70 NR	69 70 NE	66 79 60	NE NR 50	30 120 NE	30 55 55				
13	Average	127		180	172		69	68		75	47				

Legend : NR - No result.

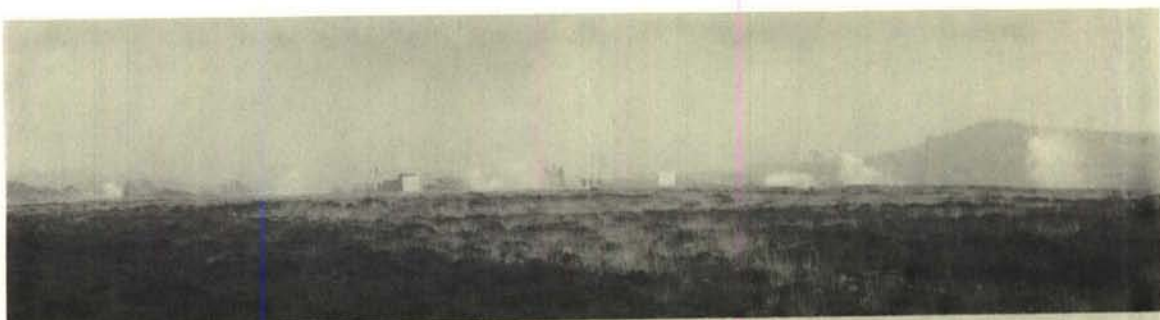
NE - No result expected due to relative position of observer to grenade.

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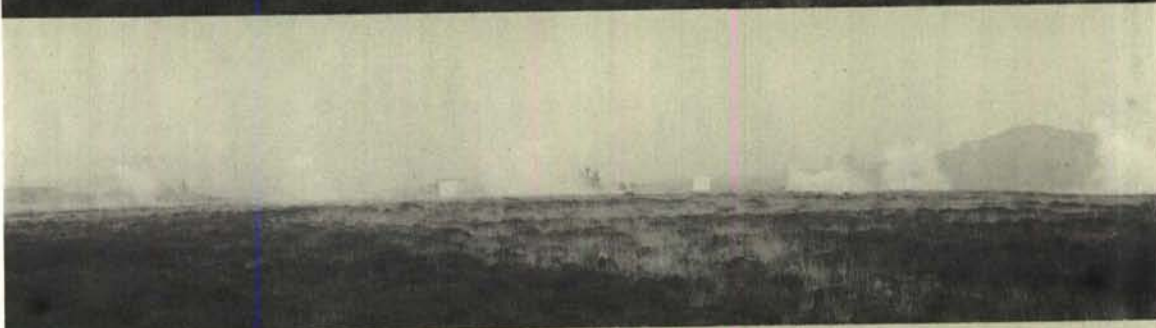
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2. Photographs of the Screen Build-Up of Table 1 Serial 1 Col (f) (12 Grenades)  
( Taken from Observer 3's Position )

a. 4 secs.



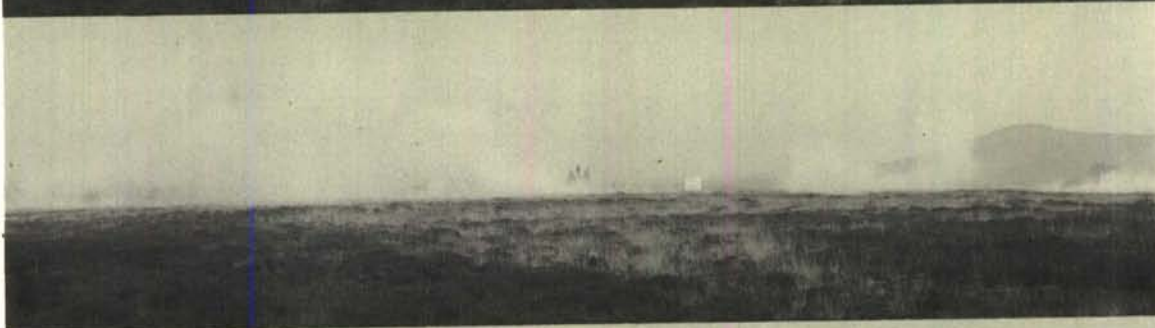
b. 8 secs.



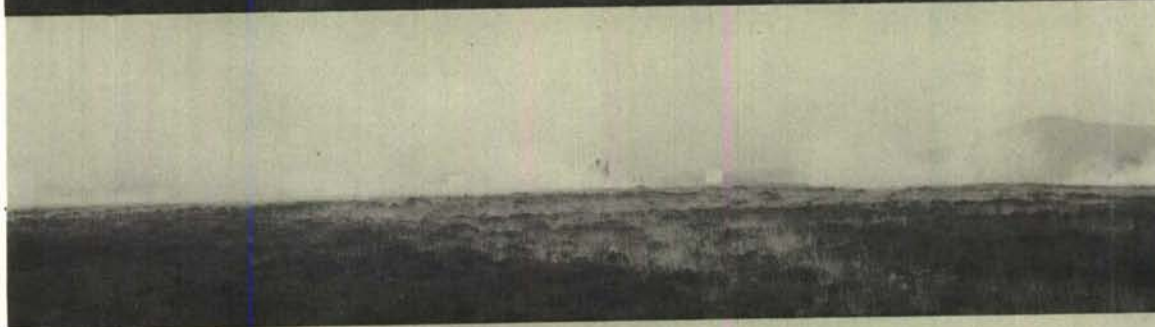
c. 12 secs.



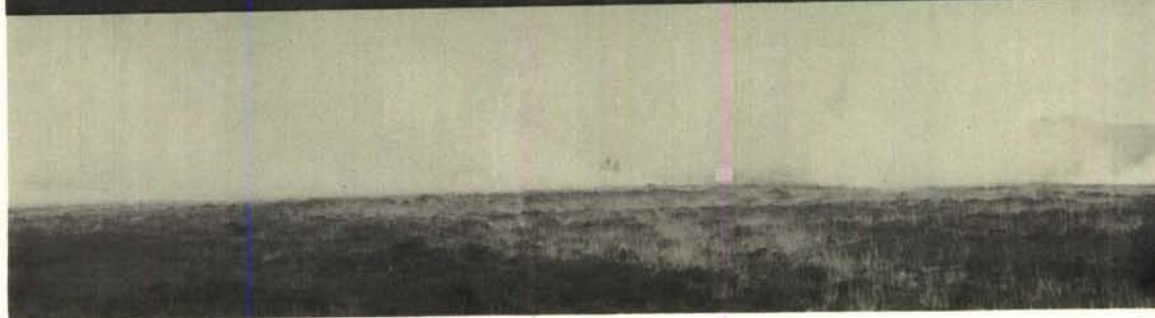
d. 16 secs.



e. 20 secs.



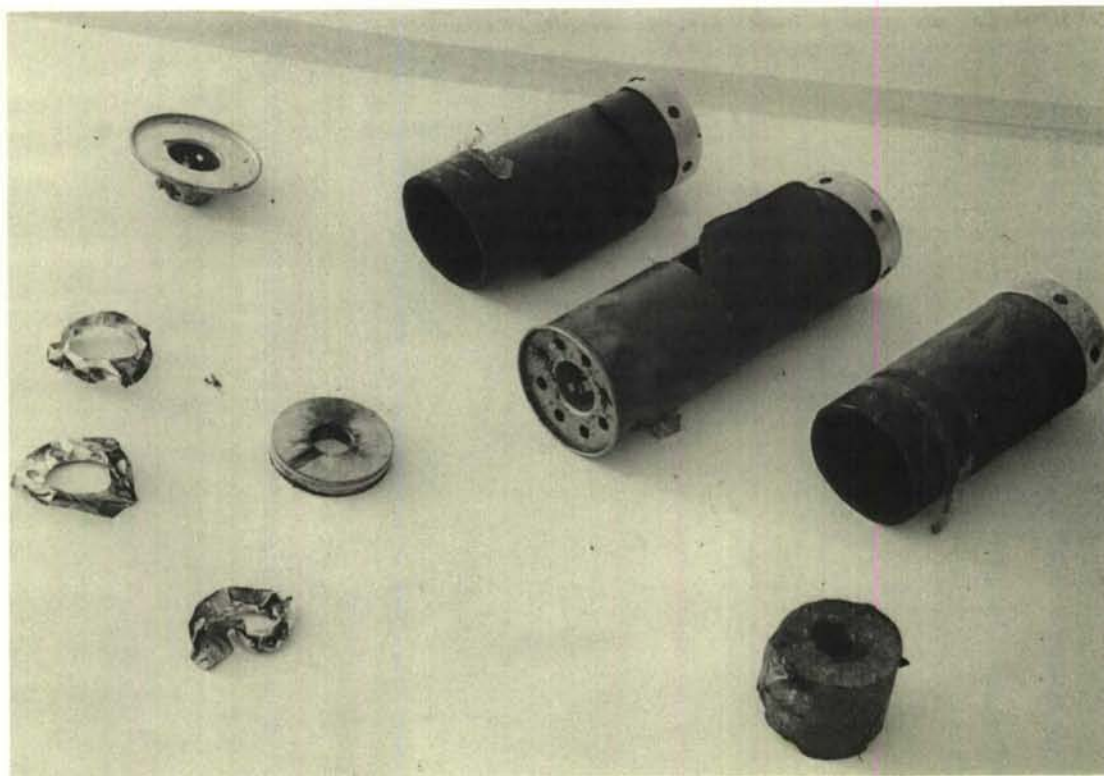
f. 24 secs.



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3. Grenade Remnants.

















The above objects, from left to right, are :

- a. Three pieces of tin foil.
- b. Base socket connection.
- c. Wooden disc.
- d. Parts of three grenades.
- e. Remains of unburnt Red Phosphorus.





TEST 2 - DETAILED RESULTS

1. Table of Results. Details of the effect of small arms fire on the three types of grenade are given in Table 1 below.

TABLE 1 Effect of Small Arms Fire

Serial (a)	Grenade (b)	Bullet Type (c)	Position in Discharger (d)	Remarks (e)
1	L 7	Trace		Grenade ignited and smoke was produced. The grenade remained in its discharger.
2	L 7	Trace		As for Serial 1.
3	L 7	Trace		Remained in discharger but burnt violently with a lot of flame but little smoke.
4	L 7	Ball		Good smoke. Ejected 25m from cup.
5	L 7	Trace		Grenade ignited and smoke was produced. The grenade remained in its discharger.
6	L 7	Ball		Grenade fell out onto ground. Smoke produced.
7	RP	Ball		Holed in centre by bullet but to no effect.
8	RP	Trace		Disintegration and particles scattered for 40m over 20° arc. Remained in cup.
9	RP	Ball		As for Serial 8.
10	RP	Trace		Fell out of cup and exploded normally. (1st shot missed).
11	RP	Trace		Immediate disintegration with phosphorus spread over wide area. Flames in cup for 30 seconds.
12	RP	Trace		Fell out of cup, disintegrated and exploded normally.
13	No 80 WP	Ball		Cap penetrated. Instant flames but no violent scattering of WP. Remained in cup but was removed later for photographs.
14	No 80 WP	Trace		Immediate disintegration. WP poured from base as a liquid.



Serial (a)	Grenade (b)	Bullet Type (c)	Position in Discharger (d)	Remarks (e)
15	No 80 WP	Ball		1st shot had little effect, but ignited by second.
16	No 80 WP	Trace		) Two shots into the ) centre of two grenade ) tops. Disintegration ) and flames, molten WP ) to rear.
17	No 80 WP	Ball		
18	No 80 WP	Trace		Scattering of WP over area.

2. Photographs. The following photographs show the respective grenade launchers after firing.

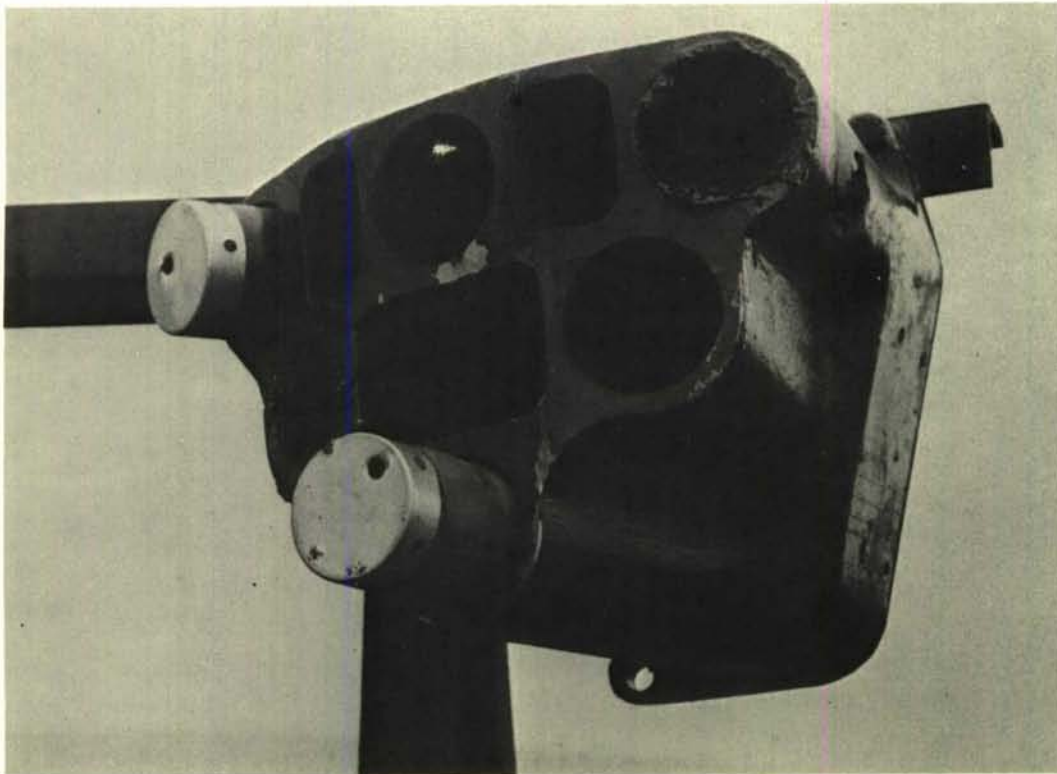


Fig 1 - The Red Phosphorus Grenade Launcher after Firing

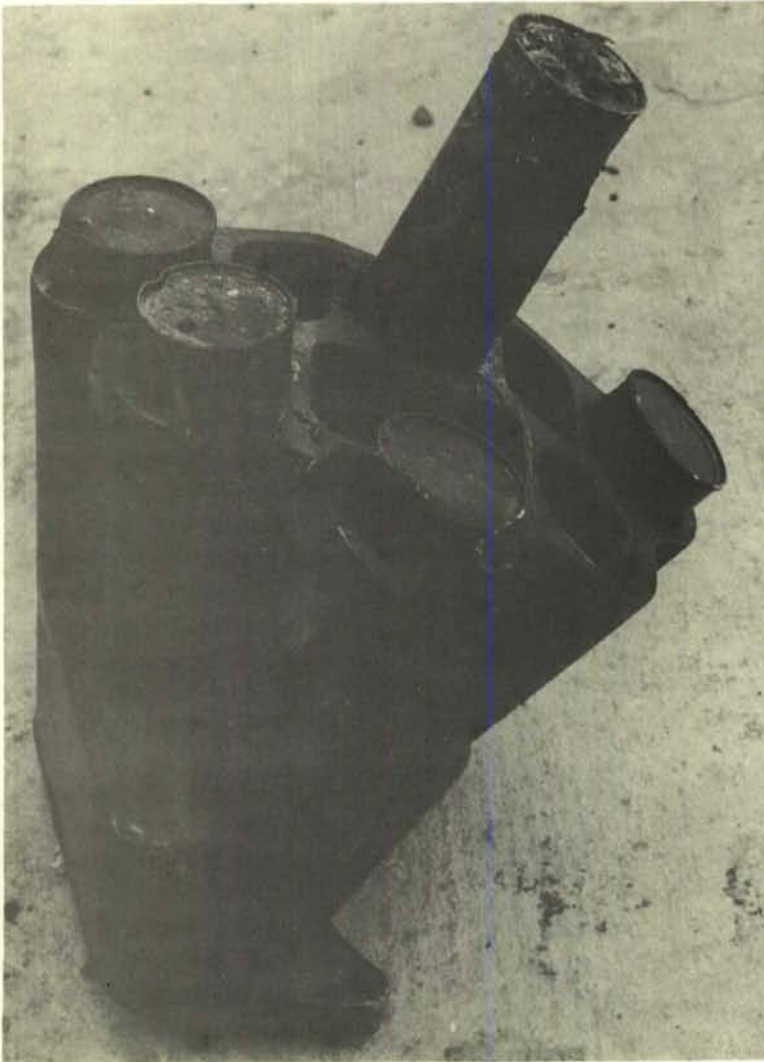


Fig 2 The L7 Grenade Launcher After Firing

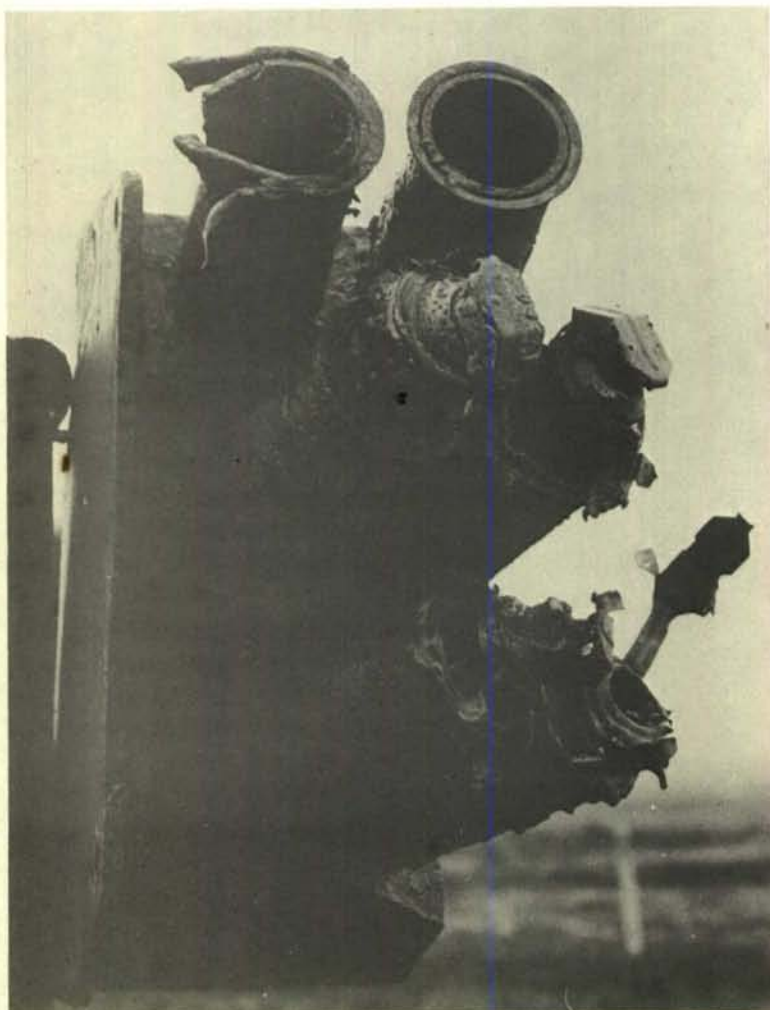


Fig 3 The No 80 White Phosphorus Grenade Launcher After Firing



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